Chapter 5 Mainline Detector System

Data from vehicle detection technology is used in real time for Freeway Management System (FMS) applications and may also be stored for planning purposes. The FMS gathers and uses real-time traffic data including speed, occupancy, and volume. Recorded data is also useful for non-FMS purposes such as monitoring traffic trends and other planning statistics. This guide does not address detector data collection for non-FMS purposes.

5.1 Overview of Detection Technology

The principal vehicle detection system for the Arizona Department of Transportation (ADOT) FMS has been in or beneath-pavement loop detectors. At certain locations (usually in retrofit or loop failure situations), however, non-intrusive above-roadway detectors, such as passive acoustic detectors (PADs) have been installed in place of in-pavement loop detectors.

Other technologies may be considered for detection provided they have been approved by the ADOT Transportation Technology Group (see Section 3.1).

5.1.1 New Installations

Mainline detector loop stations are required for the entire urban freeway system. One detector loop station is required per mile in each direction adjacent to the entrance ramp input detectors (refer to the *Ramp Meter Design, Operations, and Maintenance Guidelines*). Preformed detector loops shall be embedded in all new concrete pavement. Saw cut loops are allowed in asphalt pavements. Each set of detector loops normally consists of two 6 ft. x 6 ft. square-shaped preformed detector loops per lane, separated longitudinally by 12 ft. Each preformed loop consists of five turns. All preformed loops shall terminate in a No. 7 pullbox at the shoulder. The No. 5 pullbox, often used in the past, has proven to be too small in most applications.

Non-intrusive detection technology is often used on retrofit projects (see Section 5.1.2). Planning and providing for future non-intrusive technology supporting infrastructure is recommended for new installations. Where feasible, non-intrusive detection technology is preferably located beyond the outside shoulder of the freeway instead of in the median barrier. New freeway installations should provide supporting infrastructure at a nominal cost for future non-intrusive detection technology (such as passive acoustic detectors, i.e. PADs) on both sides of the freeway. Typically, this infrastructure consists of a lateral median conduit system (a minimum of two 3-inch conduits) from all non-intrusive detection technology foundations to beyond the opposite edge of pavement terminating in a No. 7 pullbox with extension. No pullbox in the median barrier is required; however, the conduit shall extend a minimum of 2 inches above the top of foundation, and be plugged.

5.1.2 Retrofit Projects

Non-intrusive detection technology has been the preferred retrofit detection technology for replacement of defective or out-of-place (due to re-striping) pre-existing loops. Saw-cut loops in existing pavement may be considered only if approved by the ADOT TTG.

If the designer is working on the retrofit of an existing roadway, or a restriping project on the roadway, it may be necessary to saw-cut loop detectors in the pavement surface. Typically, when a 6 ft. square-shaped loop is centered in the lane, there is approximately 3 ft. to the lane line. In a retrofit or restriping project, if the lane line shifts such that the edge of the buried loop is less than 18 in. from the new lane line, then new saw-cut loop detectors in the pavement surface or above-roadway detection systems are required. Each set of detector loops is to consist of two 6 ft. square-shaped loops per lane, separated longitudinally by 12 ft. Each saw-cut loop consists of four turns.

The loops are to be centered in the middle lane(s) and may be offset by one foot toward the shoulder in the lanes adjacent to the inside and outside shoulders. Loop detectors should be offset in the lanes adjacent to shoulders since the drivers of vehicles tend to shy toward the shoulder rather than to the adjacent lane because there is more pavement width for the driver to maneuver their vehicle in their lane plus the adjacent shoulder. However, where a future lane is planned adjacent to outside lanes, it is preferable to position the loop in the middle of the lane to anticipate the ultimate condition. Typical loop placements are shown in the FMS Standard Drawings. Auxiliary lane and high-occupancy-vehicle (HOV) lanes must have loop detectors installed similar to general-purpose lanes.

Refer to the *FMS Standard Drawings* for further details, including:

- Typical loop placements beneath jointed concrete pavements (including pavements with load transfer dowel assemblies, and the more typical plain concrete pavement)
- Typical loop placements for saw-cut loops in asphalt and concrete pavements

5.1.3 Loop Detector Requirements

Loop detector requirements are discussed in the *ADOT Standard Specifications for Road and Bridge Construction (*Sections 732 & 735), the *ADOT Ramp Meter Design, Operations, and Maintenance Guidelines,* and the *FMS Standard Specifications*. The typical loop labeling and loop wire path scheme is shown in Figure 5.1. Off ramp detectors are no longer installed except at system interchanges.

The following procedure is to be utilized for systematic design of the placement of mainline detector stations.

1. The location of the detector station upstream of the nose of the gore should not be greater than 400 ft. or less than 10 ft. from the back of gore.
2. Proceed to the next downstream interchange and repeat the process.
3. Detector stations are then to be located at a spacing of approximately 1 mile between the locations identified in steps A and B.
4. Uniformity in loop detector spacing is desired; therefore, divide the distance between the locations identified in steps A and B into approximately equal one-mile segments, and identify these points as the location(s) of the intermediate stations. If a location falls on a bridge or in a lane taper, the loop location should be adjusted such that it is beyond the nearest bridge abutment or upstream of the start of a lane taper. When an adjustment is required, the loop spacing should be no more than 1 mile from any adjacent loop detector station.

   The roadway designer should be aware of the difficulties of obtaining accurate mainline count, occupancy, and vehicle length data in the immediate vicinity of entrance and exit ramps due to the number of merging vehicles and lane changes which commonly occur. Where possible, the designer should avoid placing mainline detector stations where merging or extensive weaving occurs.

5. At least one loop detector station should be placed in each one-mile section of freeway.
6. Detector stations at system interchanges (SI) will be located to count each ramp. Each ramp will require two detector stations, one near the merge and another set of detectors at the diverge point of each ramp.
7. Repeat the process for the other direction of travel.

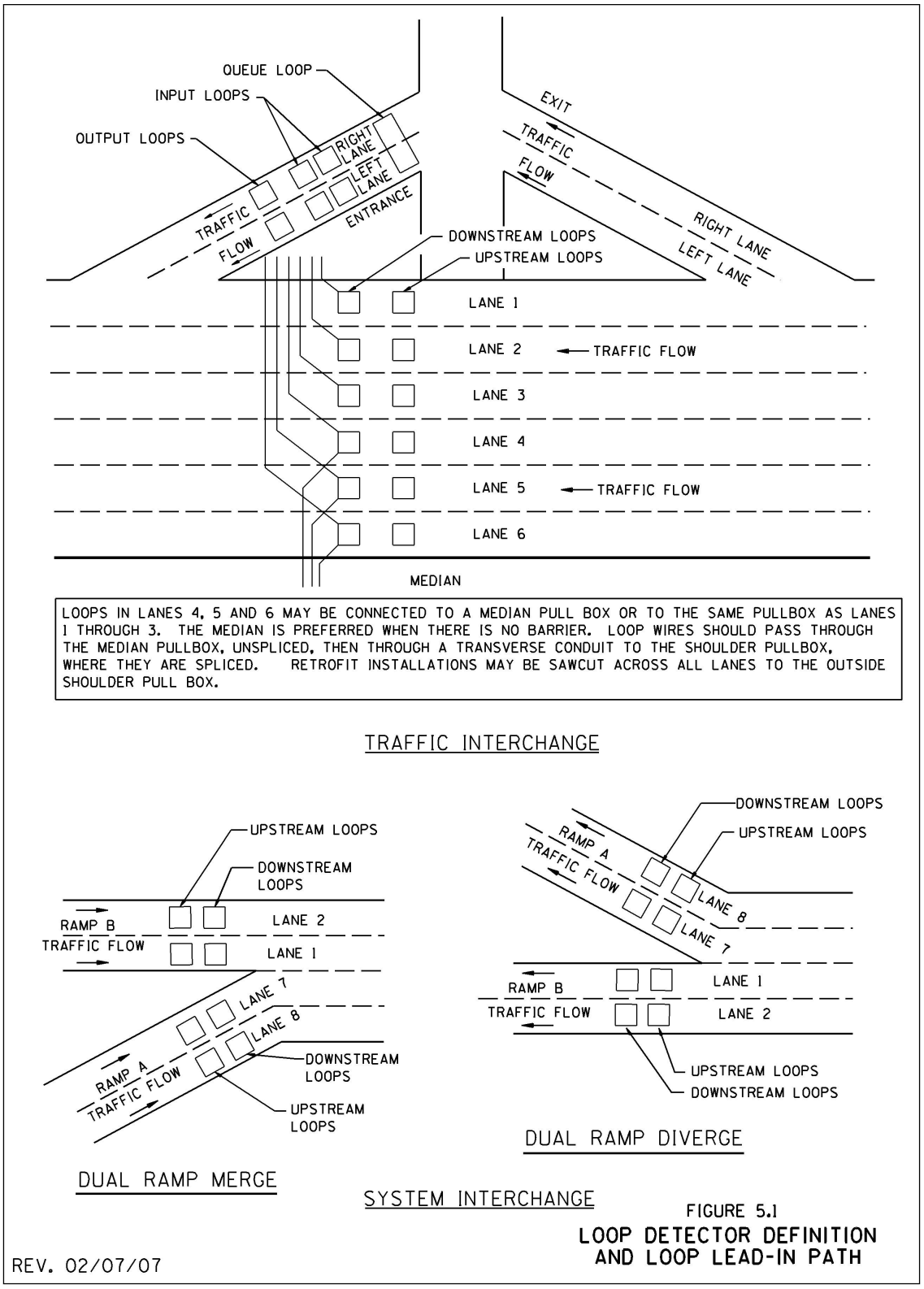

Figure 5.1 Loop Detector